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# TEM verification of the $\langle 111 \rangle$ -type 4-arm multi-junction in [001]-Mo single crystals

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# TEM verification of the $\langle 111 \rangle$ -type 4-arm multi-junction in $[001]$ -Mo single crystals

Luke Hsiung

## Objective

To investigate and verify the formation of  $\langle 111 \rangle$ -type 4-arm multi-junction by the dislocation reaction of  $1/2[111] [\mathbf{b1}] + 1/2[\bar{1}\bar{1}\bar{1}] [\mathbf{b2}] + 1/2[\bar{1}\bar{1}\bar{1}] [\mathbf{b3}] = 1/2[\bar{1}\bar{1}\bar{1}] [\mathbf{b4}]$ , which has recently been discovered through computer simulations conducted by Vasily Bulatov and his colleagues.

## Approach

TEM foils were sliced parallel to the  $(\bar{1}01)$  plane of a compress-deformed  $[001]$ -Mo single crystal (total strain: 1%, strain rate:  $1.0 \text{ s}^{-1}$ ), the foil thinning procedure was completed using twin-jet electro-polishing techniques. A  $\mathbf{g} \cdot \mathbf{b}$  (reflection vector)  $\bullet$   $\mathbf{b}$  (Burgers vector) experiment, i.e. the  $\mathbf{g} \cdot \mathbf{b} = 0$  contrast invisible criterion, was employed to verify the Burgers vector of individual dislocation.

## Technical highlight

A typical result of the  $\mathbf{g} \cdot \mathbf{b}$  experiment for verifying the  $\langle 111 \rangle$ -type 4-arm junction is shown in Figs. 1 – 3. The first two arms of  $\mathbf{b1}$  and  $\mathbf{b2}$  dislocations can be unambiguously identified (Fig. 1) using two reflection vectors:  $[\bar{1}2\bar{1}]$  and  $[121]$ , which are available in the  $[\bar{1}01]$ -zone diffraction pattern. Although the contrast of  $\mathbf{b3}$  and  $\mathbf{b4}$  dislocations become invisible using the  $[101]$  reflection vector available in the  $[\bar{1}01]$ -zone pattern [Fig. 2 (b)], they can not be individually distinguished. In order to identify  $\mathbf{b3}$  and  $\mathbf{b4}$  dislocations individually, the  $[\bar{2}01]$ -zone diffraction pattern has been used. Here,  $\mathbf{b3}$  and  $\mathbf{b4}$  dislocations can be identified unambiguously (Fig. 3) using reflection vectors:  $[\bar{1}\bar{1}\bar{2}]$  and  $[1\bar{1}2]$ , which are available in the  $[\bar{2}01]$ -zone diffraction pattern.

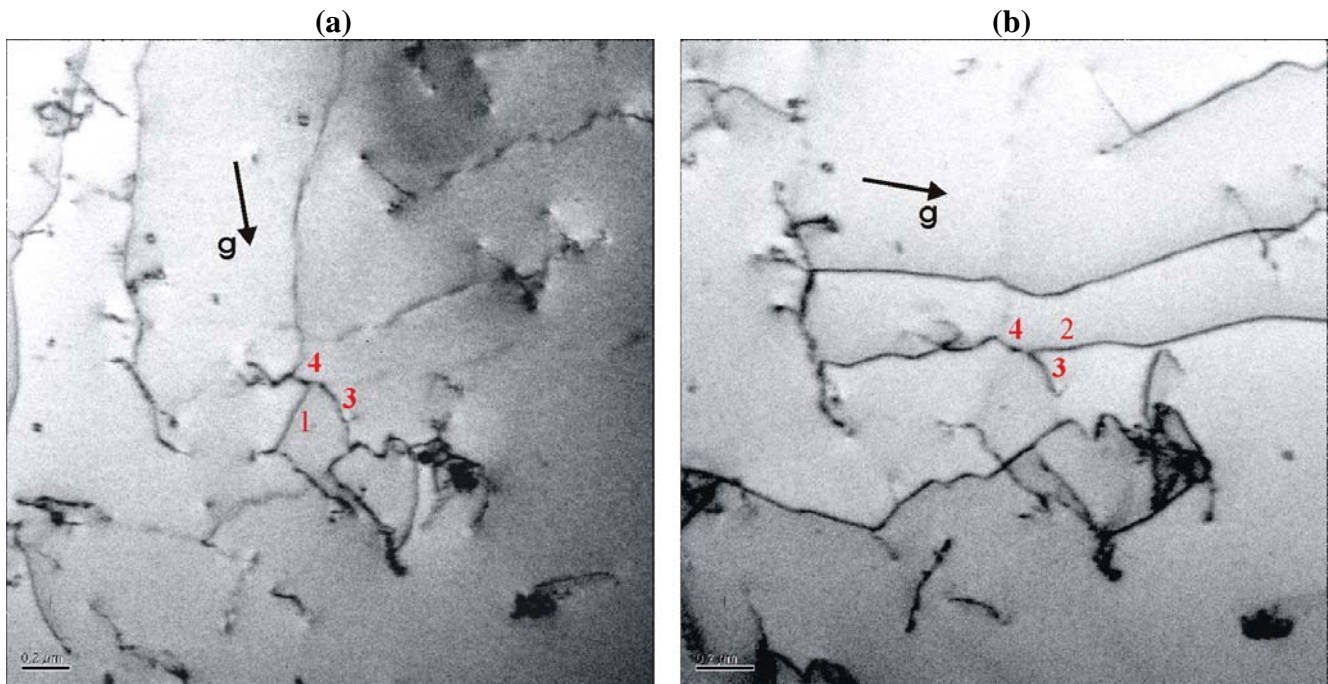


Fig. 1. (a)  $\mathbf{Z}$  (zone axis)  $\approx [\bar{1}01]$ ,  $\mathbf{g} = [121]$ ,  $1/2[1\bar{1}\bar{1}] [\mathbf{b2}]$  is invisible; (b)  $\mathbf{Z} \approx [\bar{1}01]$ ,  $\mathbf{g} = [\bar{1}2\bar{1}]$ ,  $1/2[111] [\mathbf{b1}]$  is invisible.

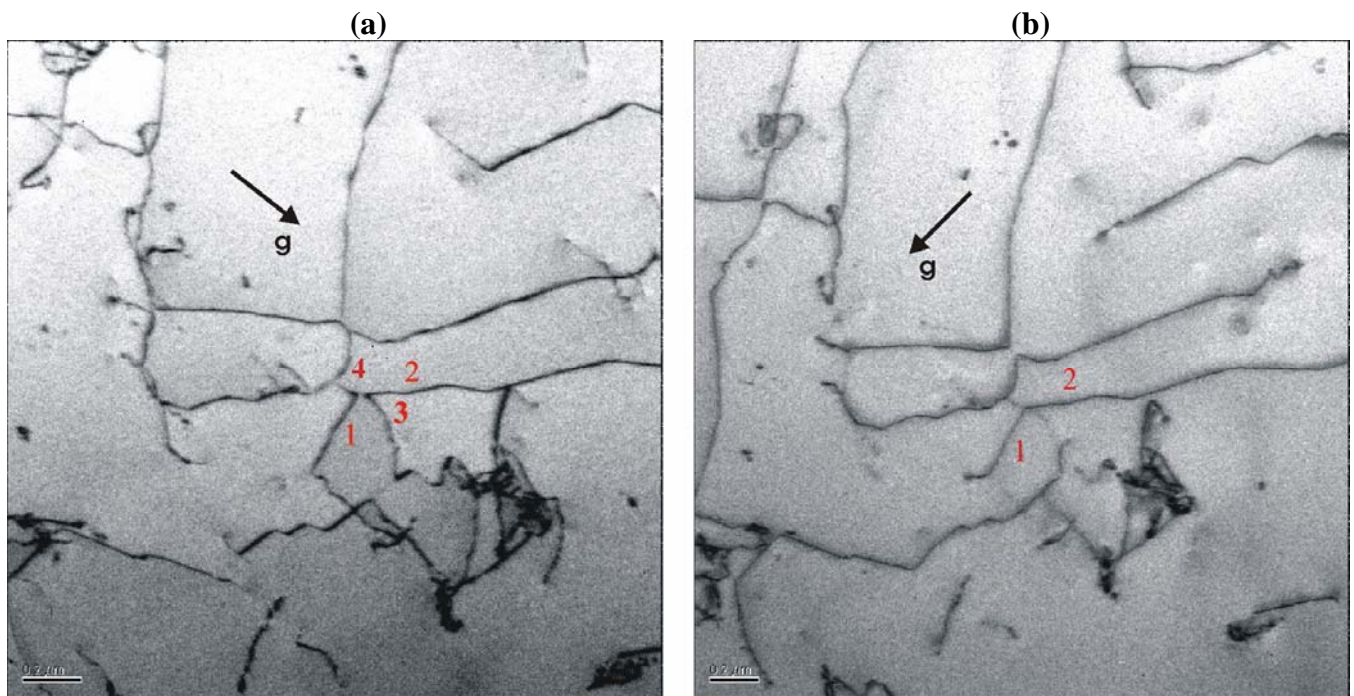


Fig.2. (a)  $\mathbf{Z} \approx [\bar{1}01]$ ,  $\mathbf{g} = [020]$ , dislocations of all four burgers vectors are visible; (b)  $\mathbf{Z} \approx [\bar{1}01]$ ,  $\mathbf{g} = [101]$ , both  $1/2[\bar{1}\bar{1}1]$  [**b3**] and  $1/2[\bar{1}11]$  [**b4**] are invisible (or have a faint contrast).

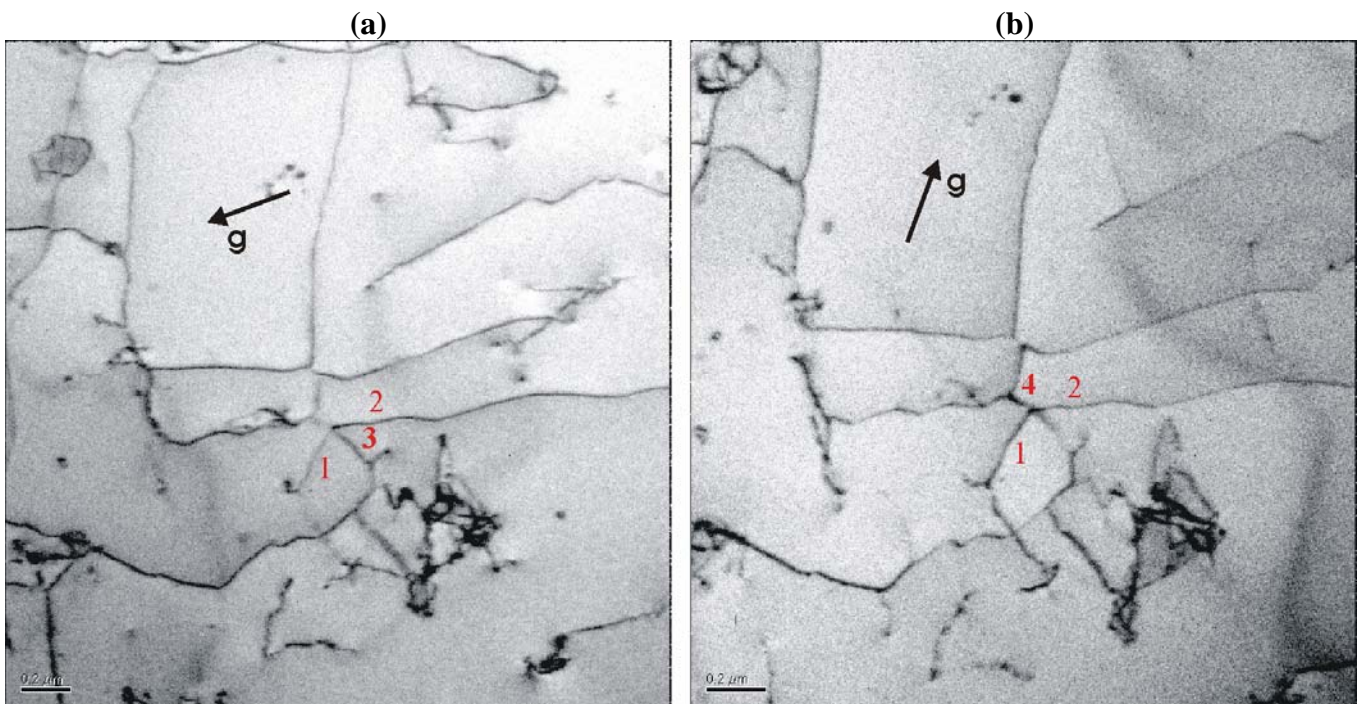


Fig. 3. (a)  $\mathbf{Z} \approx [\bar{2}01]$ ,  $\mathbf{g} = [1\bar{1}2]$ ,  $1/2[\bar{1}11]$  [**b4**] is invisible; (b)  $\mathbf{g} = [\bar{1}\bar{1}\bar{2}]$ ,  $1/2[\bar{1}\bar{1}1]$  [**b3**] is invisible (or has a faint contrast).